CL#02-2627 FINAL

Assessing Risk from a Stakeholder Perspective

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Abstract — Planetary exploration missions are subject to a vast array of interpretations of "success" based on the concerns of multiple stakeholder groups. While project risk management generally focuses on issues of cost/schedule constraints or reliability issues, a broader interpretation of "risk" as it applies to stakeholders such as sponsors (e.g., NASA), the public at large, the scientific community, the home organization, and the project team itself can provide important insights into the full spectrum of risk that needs to be managed. This paper presents a stakeholder view of risk which is divided into failure, not-a-failure, success, and stunning-success zones. Using the Mars Pathfinder mission as an example, an alternative interpretation of the risks to that mission is presented from the view of key stakeholders. The implications of the stakeholder perspective to project risk management are addressed.

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1. INTRODUCTION

A common way of defining project risk is as a "threat to success" ([6] p.8). In order to fully understand how this applies to a given project, it is important to define what "success" means. Generally, projects focus on the performance of the product relative to a set of requirements and adherence to constraints such as cost and schedule. Success, however, is not determined by these measures. Instead it is subjectively evaluated based on the criteria of importance to the various stakeholders that influence a project and are affected by it.

This paper explores the relationship between stakeholder expectations and project risk, as defined above. It first defines what a stakeholder is in general and more specifically in the context of a NASA-sponsored space mission. The paper then draws on the decision making literature to identify factors which influence people's judgment processes. Using the concept of an aspiration level, these factors are consolidated into a framework for discussing success, as represented by a "success/failure graph." To illustrate the use of a success/failure graph, the Mars Pathfinder mission is evaluated from the perspective of two stakeholder groups: the NASA sponsors and the general public. Finally, the paper explores the implications of considering stakeholders in an overall risk management approach, by drawing from the risk communication literature.

2. STAKEHOLDERS

Stakeholders are those who have the potential to influence or affect an organization, and/or be influenced or affected by it [7]. Stakeholders include internal organizational members, such as employees, managers, and board members [17]as well as external members such as customers, shareholders, the local community, and regulatory authorities [11]. Stakeholders vary in the degree to which they can exert their influence, the immediacy with which their influence is felt, the degree to which they may be affected or influenced, and the directness of this influence.

For the purposes of this paper, the "organization" of interest corresponds to an individual flight project, such as one that develops and operates an interplanetary space mission for the National Aeronautics and Space Administration (NASA). Rather than provide a complete stakeholder analysis, this work focuses on the simplified relationships between the flight project and key stakeholders such as project team members, the general public, the organization in which the project team works, and NASA, as depicted in Figure 1.

In the civilian space program, stakeholder issues for flight projects arise in a number of different ways. For example, NASA, as the sponsor for interplanetary exploration, provides the funding and oversight for the development and operation of these missions. As such, NASA exerts significant influence by selecting which projects to implement, selecting the organizations to do the implementing, prioritizing objectives,

[1] 0-7803-7651-X/03/$17.00 © 2003 IEEE, Paper # 1078

managing resources, and levying constraints and requirements. NASA is answerable to both the President and Congress who are influenced by the success or failure of NASA missions when determining future funding and priorities. These elected officials are in turn answerable to the people of the United States who ultimately bear the cost of funding NASA missions. The support of the American public is critical to the continued existence of NASA. The American public is also the intended ultimate beneficiary of NASA missions through advances in science, technology, engineering capability, general knowledge and education, and the intangible benefits associated with discovery, inspiration, and national pride.

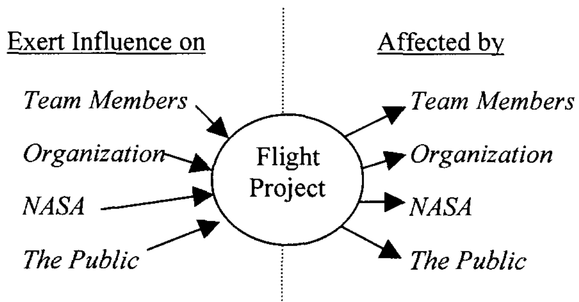

Figure 1 - Simplified stakeholder relationship with project

The home organization of the project provides the necessary local resources and has the ability to levy additional requirements and constraints on the project. One key way the home organization influences the project is through the availability of facilities and personnel with the necessary skills and expertise. The organization also rewards and recognizes the performance of team members. In return, the organization is affected by the individual project through the project's ability to contribute to the overall knowledge and skill base of the company, the goodwill generated by success, and the viability of the organization with respect to future work. Finally, the individual people who comprise the project team are those most directly responsible for the development of the product. They are influenced by the way work is allocated to them, the payment they receive for doing their jobs as well as intangible rewards, continued viability for employment, and the organizational constraints which impact how they perform their jobs.

Because stakeholders both exert influence on and are affected by the flight project, it is important to understand their concerns as they relate to the project. If a stakeholder feels that the project can affect them negatively, they will use the influence available to them to modify project behavior. For example, threat of significant cost overruns could trigger a formal NASA review to determine if the project will be allowed to continue, replacement of the key project personnel by the home organization, and voluntary turnover by project team members who don't want to be associated with a troubled project. A perceived positive effect could lead to supportive actions such as a rash of letters from the public to Congress advocating support for a project.

The ultimate determination of the success or failure of any flight project is in the hands of the stakeholders. Given that stakeholders may have competing agendas, contradictory concerns, and different bases for evaluating "success," it is important for projects to identify their stakeholders, understand their issues, and consciously address their concerns in the overall management of the project.

3. Levels of Success

Assessment of a project to determine "success" can be characterized as a decision making process relying on the personal judgment of the decision makers. It is an inherently subjective process, although objective measures (e.g., cost, adherence to schedule, measured performance of the product) are used to support the decision. Research on human decision making has identified a number of effects that influence how people make decisions. For example, Tversky and Kahneman [22] identified the adjustment and anchoring heuristic, which says that people make estimates by starting from an initial value that is then adjusted to yield a final answer.

Decision making behavior is also affected by framing and salience effects. Variation in the framing of options as either gains or losses impacts choice [8]. Prior gain or loss impacts future decisions such that managers were more willing to accept risk after experiencing a prior gain as opposed to a prior loss, and confirmed the importance of reference points [20]. March & Shapira [9] found that risk preference varies with context and the acceptability of a risk alternative depends on some critical aspiration levels for the decision maker. When decision makers are above the performance target, the primary focus is on actions that might place one below it, therefore leading to risk aversion. For decision makers below the performance target, attention is focused on opportunities for gain, leading to risk taking behaviors, except when near the survival point where risky behavior is moderated by a heightened awareness of danger.

Results from research on decision making suggest that the assessment of project success by stakeholders may be influenced in the following ways:

(1) The definition of "success" will be based on an established *anchor* point. When expectations are set (e.g., via publication of mission success criteria or claims published in the media), these expectations serve as the reference point from which actual performance will be judged.
(2) The expectations can be modified, but through a process of *adjusting* the anchor point, rather than large scale changes.

(3) The assessment of success will be based on performance relative to the anchor point, evaluated as *gains* or *losses*.
(4) *Prior experiences*, including gains or losses possibly unrelated to the given project, will influence behavior.
(5) There are *critical aspiration levels* (e.g., minimum success criteria vs. nominal) that influence decision maker behavior.
(6) Performance near the *survival point*, which represents a level of performance under which the viability of the organization is threatened, results in altered decision maker behavior.
(7) The salience of the project to stakeholder interests will also influence decision maker behavior.

Since determining "success" is an interpretive act of judgment affected by the biases and perspectives of the person(s) making the assessment, it is important to develop a model of mission success that relates stakeholder concerns to project outcomes. Figure 2 provides an overview of such a conceptual model, the "success/failure graph." The x-axis consists of a set of events of importance to stakeholders. These events can either represent the incremental attainment of project goals, or they can represent possible failure events. The placement of these on a continuum is meant to suggest the incremental nature of both positive and negative events, but discontinuities are also acceptable. The y-axis consists of a series of a series of judgmental levels. The dotted, vertical line represents the *aspiration level*, which is the event that corresponds to achieving project "success."

There are five levels indicated on the success/failure graph:

(1) *Catastrophic Failure*: represents the survival point for the stakeholder. Performance which falls to this level places the stakeholder at risk for serious harm. The loss of the Space Shuttle Challenger, and the Apollo 1 fire are representative examples for this level.
(2) *Failure*: represents the point at which performance is so poor that no substantive concerns of the stakeholder are met. Examples for this level include the cancellation of a project due to cost overruns, or failure to reach the target orbit by a satellite.
(3) *Success*: represents the point at which a sufficient amount of stakeholder expectations have been satisfied. Examples for this level include meeting minimum success criteria, completion of the scientific mission in a way that meets expectations.
(4) *Stunning success*: represents the point at which expectations are exceeded and something of special importance has been achieved. Examples for this level include the pictures of a volcanic eruption on Io by the Voyager spacecraft and the huge public response to the Mars Pathfinder.
(5) *Phenomenal success*: represents a point far beyond the possible expectations of stakeholder groups, and can be considered more as the ultimate unobtainable goal rather than an actual event. An example of an event that could fall into this category is the future discovery of extant life on a comet or on Mars.

The proposed levels are highly subjective and non-linear in terms of the efforts to transition from one to another or the benefits to be gained by such transitions. One area of special interest on the graph is the zone that exists between failure and success, referred to as the "not a failure" zone. While it is tempting to think of failure and success as opposites, the complexities of space missions as well as the potential variety in stakeholder concerns creates an array of competing, often contradictory, criteria upon which to evaluate success. It is rare that all criteria can be simultaneously satisfied, leading to

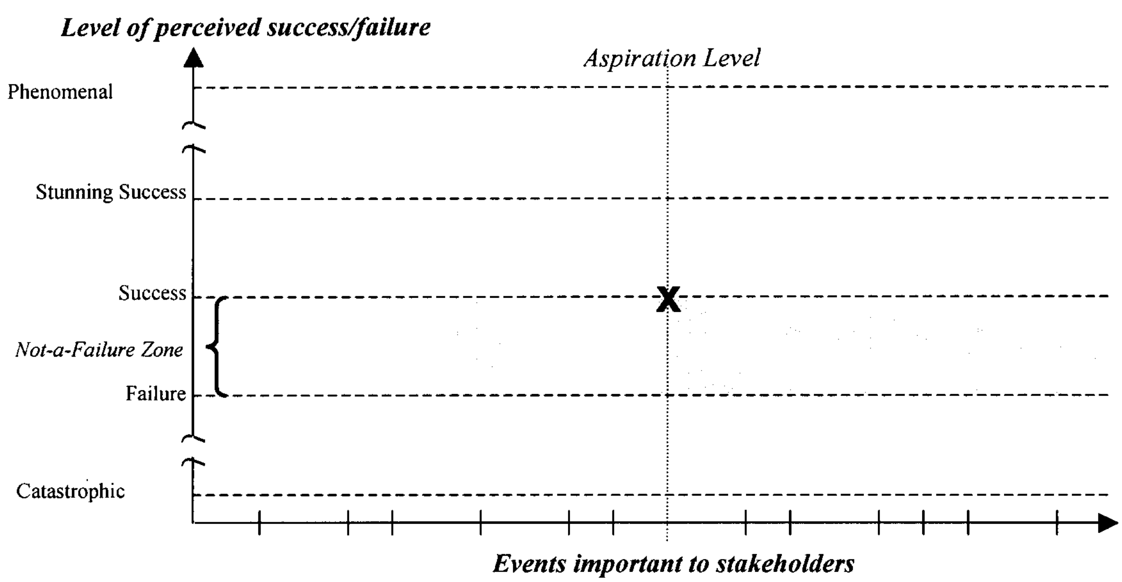

Figure 2 -- Success/Failure Graph

difficulty in predicting exactly where the transition to success can occur.

4. MARS PATHFINDER EXAMPLE

To illustrate the application of this model, consider the Mars Pathfinder mission. The July 4, 1997 arrival of Pathfinder on the surface of Mars, followed by the deployment of the Sojourner Rover became a historical event and one of NASA's biggest triumphs (c.f.,[14]). This example will look at Pathfinder from the perspective of two stakeholder groups, NASA and the general public, as illustrated in Figure 3. Mars Pathfinder was the second launch in NASA's Discovery program, an initiative for planetary missions developed under "faster-better-cheaper" conditions. The mission was conceived primarily as an "engineering demonstration of key technologies and concepts for eventual use in future missions to Mars employing scientific landers" [2]. Pathfinder also delivered science instruments and the Sojourner Rover to the surface. Through a series of negotiations, the mission success criteria for Pathfinder [1] were established as:

1. Successful landing and return of entry, descent, and landing engineering telemetry – 70%
2. Acquisition and transmission of a single panoramic image – 10%
3. Successful rover deployment and operation – 10%
4. Complete 30 sol primary lander mission; complete all additional engineering, science, and technology objectives – 10%.

Based on these criteria, NASA, as the sponsor and a stakeholder in the Pathfinder mission formally established the *success* line (assuming a passing grade of 70%) at the landing of the spacecraft on Mars (item 1). Items 2-4 represent additional credit, which once achieved would satisfy the expectations of the stakeholder. When Pathfinder exceeded these criteria, by performing well beyond the 30 sol primary mission and returning significantly more data from both stationary instruments and the Sojourner Rover, it began to approach the *stunning success* level. What arguably led to the triumph of the Pathfinder mission, however was the outpouring of public support which translated into Congressional support for the overall NASA budget (c.f. [14]).

Less obvious, however, is where the "not a failure" line was drawn. As one of the early faster-better-cheaper missions, the Pathfinder project attempted to develop a mission in roughly half the time as previous missions and for a significantly smaller budget. The actual delivery of the spacecraft in that reduced amount of time itself constituted a level of accomplishment important to the NASA stakeholder. While the delivery and on-time launch of the spacecraft alone were not enough to attain "success" status, they effectively promoted Pathfinder to the "not a failure" zone. If something such as a launch vehicle failure were to have happened at that point to end the Pathfinder mission, the Pathfinder *project* could still have been considered a success, although the Pathfinder *mission* would have ended prematurely. These levels are represented by the circles in Figure 3. Note that while drawn as single-points, they do not represent precise values.

Pathfinder, however, was viewed quite differently by the general public. The Pathfinder project put extensive effort into education and public outreach. Special programs were set up with educators, including the highly successful Red Rover Goes to Mars [c.f., 3]. In the years leading up to the Mars

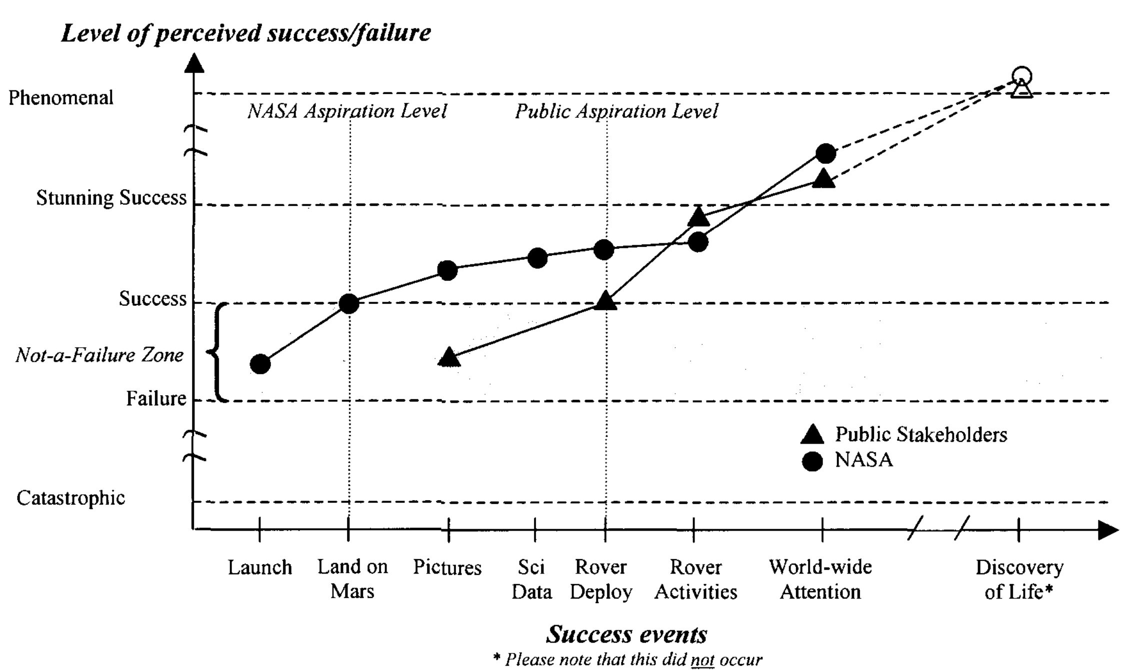

Figure 3 – Example Success/Failure Graph for Mars Pathfinder

landing, members of the Pathfinder project team were visiting classrooms, participating in on-line chats, and featured in television and radio programs, promoting the upcoming Pathfinder mission. As excitement grew for the project, public interest began to focus on the Sojourner Rover (c.f.,[13] In fact, people commonly confused the $150M Pathfinder mission, which consisted of the cruise stage, the entry, descent, and landing system, and the Pathfinder Lander, with the $25M Sojourner Rover technology demonstration that was a passenger on the Pathfinder Lander.

From the view of the general public stakeholders, the success of the Pathfinder mission became synonymous with the success of the Rover. Therefore it is conceivable that the following success levels[2] could have emerged. Landing on the surface of Mars (success criteria item 1). As *proven* by the return of actual pictures (item 2) from the surface of Mars placed Pathfinder into the *not a failure* zone for public stakeholders. It was the accomplishment of item 3 (allocated only 10% of the overall formal success criteria) coupled with pictures of the Sojourner Rover operating, however, that firmly pushed Pathfinder above the *success* line. Finally, it could be argued that the combination of the accessibility of the data, the "cuteness" of the rover, the sequences of images converted into rough "movies", the immediacy of internet access, and the overall human interest aspect of the project team resulted in a shared public experience, and the resulting phenomenon pushed Pathfinder to the level of *stunning success*. Finally, although this didn't happen, an example of an event that would have lifted Pathfinder to the *phenomenal success* level would have been the discovery of life.

While these characterizations are based on highly subjective assignments of success levels and attributions of mission milestones, and they address only a small subset of stakeholders, they do show that the definition of success can vary between stakeholder groups. This example illustrates that success levels, for example, can be formally defined and quantified (as with the NASA mission success criteria) or emerge from chaotic social processes that build expectations. While projects have enough to worry about meeting their formally agreed-upon goals, it is important to understand how project decisions could impact stakeholders, and the potential repercussions back to the project.

5. Implications for Risk Management

Risk is generally defined as a combination of an undesirable outcome and the probability of it occurring [24]. Risk management in the project environment commonly includes two areas: reliability/product performance and financial/project performance. Product-focused techniques such as Probabilistic Risk Assessments (PRA, e.g., [4]) are used to assess the likelihood that the space mission will fail in the intended environment. These techniques identify potential causes of failures, assess the probability of them occurring, determine the consequence of them occurring, and feed this information back to the development process. Project-focused techniques, however, focus on the performance of the project relative to cost, schedule, or other resource constraints. Risk management efforts in this area are intended to ensure that the project has sufficient resources to cover potential technical problems, while satisfying resource constraints [6;23].

These complementary components of project risk management, however, do not address the risks that surface due to unresolved stakeholder issues. Nor do they address the larger question of "success." From the stakeholder perspective, risk can be defined as the *probability of not meeting stakeholder expectations* which results in negative consequences for the project. This implies that risk management must also include the process of *managing stakeholder expectations* by, for example, identifying stakeholder groups, identifying their concerns, understanding how project decisions impact different stakeholders, and taking actions to minimize negative (or maximize positive) effects.

When projects interact directly or indirectly with their stakeholders, they have the potential to influence expectations. The formal negotiations to develop mission success criteria is one such instance where there is an explicit, direct effort to reach a shared understanding of what constitutes success. On the other hand, a project team member speaking before a public audience represents a more subtle, less direct attempt to influence stakeholders, without necessarily having a shared understanding. These informal stakeholder interactions carry with them the risk of creating an unrealistic expectation. For illustration purposes, if the project team member paints an exciting picture of the hoped for results from a mission (e.g., the airbag landing on Mars, the Rover exploring the Martian terrain) without adequately conveying the non-insignificant probability that something could go wrong, the stakeholders' anchor point is set based only on the positive image presented by the team member, without being balanced by the associated risks. From then on, for that group, the accomplishments of the mission will be adjusted from this reference point.

Building expectations isn't limited to interactions with the general public. In every interaction with every stakeholder, there exists the possibility of miscommunication and misinterpretation. The ad hoc cost estimate based on an incomplete understanding of the requirements, the implied agreements in organizations that responsible risk taking by individuals will be rewarded, and the misinterpretation of a back of the envelope guestimate as if it were obtained through extensive analysis, represent other ways in which expectations can be erroneously established.

Managing expectations is further complicated because they can be heavily influenced by external events. For example,

[2] For illustration purposes only, based on the author's personal experience rather than actual data.

the Mars Pathfinder success both raised the bar with regard to what constituted success, and reduced the perceptions of the risk involved in conducting subsequent missions. This was most painfully experienced during the failures of Mars Climate Orbiter and Mars Polar Lander. Although NASA's overall record with regard to Mars missions is strong, the dual failures of these missions following the success of Pathfinder contributed to pushing these events further below the failure line toward catastrophic failure, particularly for the future Mars missions that were cancelled as a result.

The assessment of performance is not a one-time decision, made following the completion of a project. Instead, these assessments are made in progress, when stakeholder influence can have a significant impact. They are also made and revised after the project has ended, with surprising potential for changes. For example, Shapira and Berndt [18]) describe several grand scale projects such as the Sydney Opera House, the Brooklyn Bridge, and the Erie Canal that were plagued with cost overruns, schedule slips, political battles, and myriad difficulties. In progress, these efforts faced the threat of cancellation, replacement of key personnel, and other negative actions. In hindsight, however, they are judged not on the shortcomings of the projects that built them, but on their contributions to society, and are therefore referred to as "successes." Even the stunning success of Pathfinder has been revisited in light of the more recent Mars failures as an example of learning the wrong lessons [25].

Research in risk communications offers numerous insights on how to address stakeholder issues for projects. The National Research Council [15] defines risk communication as "an interactive process of exchange of information and opinion among individuals, groups, and institutions. It involves multiple messages about the nature of risk and other messages, not strictly about risk that express concerns, opinions, or reactions to risk messages or to legal and institutional arrangements for risk management" (p.21). They further define risk communication to be successful "to the extent that it raises the level of understanding of relevant issues or actions for those involved and satisfies them that they are adequately informed within the limits of available knowledge" (p. 26).

Understanding "outrage factors", preexisting views, and potential controversies [10] and who the intended audience is and what they already know [5] are important in designing effective risk communication messages. Risk messages are difficult to formulate in ways that are accurate, clear, and not misleading [5]. Risk communication can fail due to inadequately addressing the needs of the recipients. Rowan [16] identifies the lack of familiarity with a particular concept or term, the lack of a mental model relevant to the subject at hand, and the existence of misconceptions as possible barriers to comprehension. Establishing trust [19] and using multiple methods to convey information [21] are two ways in which to improve risk communications.

While risk communications research has focused extensively on large scale societal issues with the potential for catastrophic results [12], there is potential value in treating all interactions with stakeholders with a degree of care. As part of an overall project risk management effort, resources allocated to managing stakeholder expectations can be used to create a more balanced view of the risks and opportunities present in space missions without diluting the inherent excitement. They can be used to quickly identify critical stakeholder issues prior to them reaching catastrophe level, and they can serve to provide a clear, shared understanding of what is meant by "success" for the individual project.

6. Conclusions

This paper advocates the extension of project risk management practices to address the management of stakeholder expectations. The case is made that these expectations establish the criteria against which project success/failure is judged, which in turn may motivate stakeholder actions that have a negative impact on the project. By defining what "success" looks like a priori , a project team can focus on what's most important. They will be better able to understand stakeholder concerns and make decisions that consider the potential impacts – both good and bad – on different stakeholder groups.

The Success Chart is a handy tool for conceptualizing stakeholder concerns and categorizing them in a way that facilitates project management. The milestones/events that constitute the x-axis should be readily available to the project. The broadly defined levels of success encourage project members to apply their own judgment in what is a fundamentally subjective, qualitative process, rather than struggle with quantification. The Success Charts also provide a mechanism for comparing stakeholder concerns, possibly illuminating conflicts or areas of mutual concern.

The work presented in this paper is in a conceptual phase and therefore strong conclusions are not warranted. While including a stakeholder perspective has the potential to contribute to an overall risk management effort, doing so has not been thoroughly evaluated with regard to the costs of addressing stakeholder-related risk issues, nor have the potential benefits been quantified. This approach has not been applied in practice except in an ad hoc way, so there are no findings relative to the impact on actual project performance. The value of this work then is in redefining stakeholder interactions in terms of how they contribute to overall project risk, and in opening a discussion on the implications for project risk management.

Acknowledgements

The work described in this paper was performed in part at Stanford University, sponsored by NSF Grant #DMI-9996081, and was completed at the Jet Propulsion Laboratory, California Institute of Technology, under a contract with the National Aeronautics and Space Administration.

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